Holistic utilization of oregano: optimization of essential oil distillation and valorization of distilled oregano waste

*Ioannis Velopoulos, Nikoletta Solomakou, Kyriakos Kaderides, Athanasia M. Goula**

Department of Food Science and Technology, School of Agriculture, Forestry and Natural Environment, Aristotle University, 541 24 Thessaloniki, Greece

*Corresponding author: E-mail: athgou@agro.auth.gr

INTRODUCTION

Origanum vulgare* ssp. *Hirtum, also called "Greek oregano", is characterized by a high concentration of exceptional essential oil (Goliaris and Skroubis, 1992). Oregano oil has long been used in traditional medicine for its antimicrobial, anti-inflammatory, antifungal, and antioxidant properties as it is rich in the monoterpenic phenol carvacrol and its isomeric analog, thymol. Conventional methods of extraction have some drawbacks, such as the difficultly to control the heat transfer throughout the process and the long extraction time. The extraction of essential oils using an **ultrasound-assisted** process, which is based on **cavitation** phenomena, leads to many benefits, such as high extraction yield, low energy consumption and processing time, and high reproducibility (Wen et al., 2020). Moreover, the recovery of valuable biologically active substances and their application to food industry is critical as the essential oils industry generates large amounts of wastes.

The objective of this work is the holistic utilization of oregano through a) the optimization of essential oil hydrodistillation using ultrasounds pretreatment or ultrasound-assisted hydrodistillation and b) the valorization of distilled oregano waste for the recovery of phenolic compounds.

MATERIALS AND METHODS

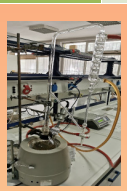
Table 1. Experimental design for ultrasound-assisted hydrodistillation (13 experiments).

Factors	Levels				
Amplitude (A, %)	50	56	70	84	90
Pulse duration/pulse interval (on/off, s/s)	3/4	14/15	11/8	11/6	2/1

Table 2. Experimental design for hydrodistillation with ultrasound pretreatment (20 experiments).

Factors	Levels				
Amplitude (A, %)	50	58	70	82	90
Pulse duration/pulse interval (on/off, s/s)	3/4	1/1	11/8	7/4	2/1
Time (t, min)	30	36	45	54	60

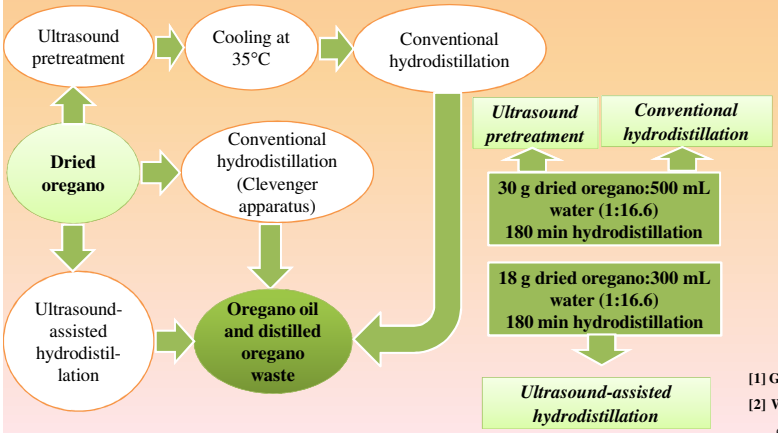
Dried oregano



Ultrasound-assisted hydrodistillation

Ultrasound pretreatment

130 W, 20 kHz, VCX-130 Sonics & Materials, with Ti–Al–V probe (13 mm)



RESULTS AND DISCUSSION

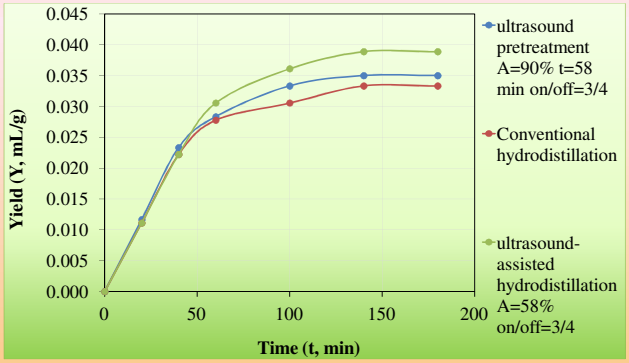
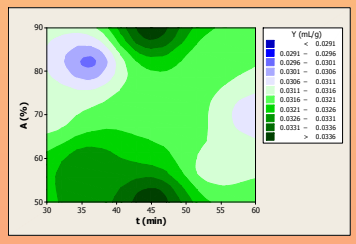


Fig 1. Effects of different hydrodistillation methods on the kinetics of oregano oil extraction.

Table 3. Mean values of statistical parameters for kinetic modelling of a) hydrodistillation with ultrasound pretreatment and b) ultrasound-assisted hydrodistillation

a)	Peleg's model			1st order model		
	R^2	R_{adjust}^2	SEE	R^2	R_{adjust}^2	SEE
average	0.950	0.943	0.0031	0.957	0.952	0.0028

b)	Peleg's model			1st order model		
	R^2	R_{adjust}^2	SEE	R^2	R_{adjust}^2	SEE
average	0.984	0.981	0.0015	0.990	0.988	0.0011



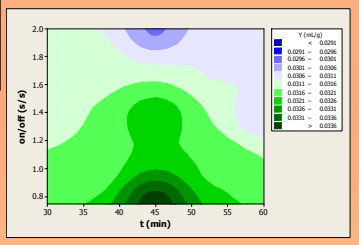


Fig 2. Effect of operating conditions on the extraction yield (Y, mL/g) for hydrodistillation with ultrasound pretreatment.

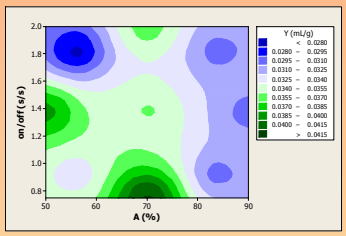


Fig 3. Effect of operating conditions on the extraction yield (Y, mL/g) for ultrasound-assisted hydrodistillation.

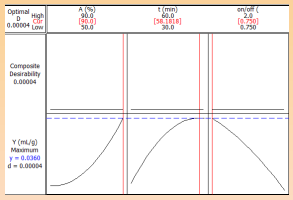


Fig. 4. Optimization plot for hydrodistillation with ultrasound pretreatment.

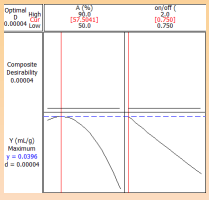


Fig. 5. Optimization plot for ultrasound-assisted hydrodistillation.

REFERENCES

[1] Goliaris, A., & Skroubis, B. (1992). New clones of Oregano. In National Congress on Agricultural Research (pp. 201-214).

[2] Wen, L., Zhang, Z., Zhao, M., Senthamaraikannan, R., Padamati, R.B., Sun, D.W., & Tiwari, B.K. (2020). Green extraction of soluble dietary fibre from coffee silverskin: impact of ultrasound/microwave-assisted extraction. International Journal of Food Science & Technology, 55(5), 2242-2250